

REMARKS/ARGUMENTS

Claims 1 and 21 have been amended to include the subject matter of original Claims 2 and 5. Original Claims 2 and 5 have accordingly been cancelled.

Claim 1 now specifically recites a range sensing system wherein *the system indicates from the range values of the sensing elements a range value for each target of the plurality of targets sensed by the at least one receiver, substantially at the same time.*

Claim 1 has been further amended to include at least one receiver “*having a plurality of sensing elements configured to sense the reflection of emitted energy from a plurality of targets with said region.*”

The Applicant asserts that it will be understood by a person skilled in the art reading the Specification that the term “receiver” has been used to denote a device. For example, in the preferred embodiment the receiver is a charge coupled device (CCD) camera (page 16, line 14). Other examples of receiver cited include CMOS cameras, Vidicon tubes, photodiode arrays and photomultiplier arrays (page 8, lines 17-18).

It is well known to those skilled in the art that each of these types of receiver generally include a plurality of sensing elements. Typically the sensing elements may be arranged in a planar array, as for example in a digital camera, in which case the sensing elements may be pixels each containing information about a limited portion of the sensed scene.

A receiver having a plurality of sensing elements is a key component of the present invention as this may enable spatial differentiation of the plurality of targets in the region, as typically different targets (or component parts of a single target) will be sensed by different sensing elements.

Information on each of the targets may therefore be obtained by analysis of output signals from each of the sensing elements (pixels in the case of a digital camera).

Further fair basis is provided on page 12, lines 15-20 which reads:

"The output signal obtained from the receiver may be generated from light reflected by a particular target, and in most instances would be represented by pixels generated through use of a CCD camera as a receiver. A single target or object within a particular region may therefore be represented by multiple pixels, with each pixel indicating range information for component portions of a target."

The role of the plurality of sensing elements, in this, instance pixels on a camera sensor, is provided on page 18, lines 11-17 which read:

"Because signals H and J are derived from light imaged on to the camera's sensor, each of these signals represent the intensity of the pixel of which the light is intersecting. Similarly, every other pixel on the camera's sensor will generate a similar waveform relating to the light reflected from the object(s) in that pixels field of view. The combination of waveforms from all of the camera's pixels will result in a time series of images, in which each pixel in the image contains one quantised time-slot of that pixel's corresponding waveform."

An advantage of this arrangement is that the analysis of information from each pixel, in this case corresponding to an individual sensing element, may be processed to provide range information essentially for the entire scene captured by the receiver, i.e. "*plurality of targets within a region*". In this way information pertaining to all targets within a viewed region can be obtained substantially at the same time.

Claim 1 has been further amended to recite "*an output signal of each sensing element of said at least one receiver has a frequency substantially equal to the frequency difference between said receiver frequency and said source frequency*". Fair basis for this amendment may be found for example on page 10, lines 23 – page 11, line 1 where it is stated:

"In a preferred embodiment the source and receiver frequencies employed may be selected from different frequencies. These frequencies may preferably be slightly offset from one another with the size of the frequency difference being approximately equal to the operating frequencies employed by a relatively low cost signal processing and imaging acquisition equipment."

Further on page 11, lines 16-18:

“Due to the wave mixing effects provided through driving the receiver and source at slightly offset frequencies, a resultant receiver output signal can be obtained with a frequency equal to the frequency difference between the driving receiver and source frequencies.”

The advantage of this for the present invention is provided on page 11, lines 18-21:

“This output signal, which can have a substantially lower frequency than the source or receiver frequencies, can therefore be analysed and manipulated easily by relatively low cost signal processing and imaging acquisition components.”

Thus the present invention combines use of a receiver having a plurality of sensing elements where each element contains information about a particular element of the viewed scene, this enabling spatial resolution of the targets in the viewed region, with the use of a heterodyne technique to provide a signal which can be analysed and manipulated readily in real time by relatively low cost signal processing and imaging acquisition components.

This may be a major advantage, for example in implementing a range sensing system for use with machine vision applications in a cost effective manner (see for example page 15, lines 9-12 and 17-20).

Claim 21 has been amended similar to Claim 1 discussed above.

The Applicant submits that independent Claims 1 and 21, as herein amended, clearly differentiate over the inventions cited as prior art by the Examiner.

Munro, column 37, line 60 –column 38, line19 does describe an embodiment in which an array of sensing elements may be used to “*create a three dimensional image of an object*”, i.e, to extend the method to measurement of a plurality of targets at substantially the same time. Munro also suggests the use of a CMOS imager.

However, the invention disclosed by Munro requires use of sensors and processing which are fast enough to cope with the use of a burst waveform signal (frequency ~20MHz) – see for example, column 38, lines 19 – 20, which read:

“In any case, the receiving elements must be fast enough to respond to the burst waveform signals reflected by the target.”

The Applicant notes that common CMOS arrays are nowhere near fast enough to be used in the manner described by Munro.

In contrast in the present invention is directed towards the use of an array of sensing elements that do not need to have a fast response.

This is made possible by the use of source and receiver frequencies which differ only slightly, and an output signal having a frequency equal to the difference between the source and receiver frequencies (~1-10 Hz).

This down-conversion process enables the signals from each sensing element to be captured and processed at a relatively slow rate suitable for more common, relatively low cost signal processing and imaging acquisition components – such as a CCD camera or common CMOS arrays.

This may greatly enhance the usability of the present invention, particularly in industrial applications such as robotic vision where fast response times, with all the associated processing requirements, are neither practical nor economic.

The use of a CCD camera (for example) for conventional range imaging systems is non-obvious as by their nature their response is relatively slow – for example it is much too slow to use with the invention disclosed in Munro.

Neither Munro nor any of the other publications sited by the examiner disclose the use in a range imaging system of an output signal being the difference between the source and receiver frequencies.

The invention disclosed by Munro does not anticipate the present invention.

As Claims 1 and 21 as herein amended are considered novel and inventive over Munro, the remaining claims, which are dependant on one or other of Claims 1 or 21, are also considered novel and inventive.

Therefore, the rejection under § 102 should be withdrawn. As for the rejections under § 103, these rejections should also be withdrawn since the secondary references cited in these § 103 rejections do not overcome the deficiencies of the primary reference, Munro. More specifically, Glaser, et al; Rafi; Keneko, et al; Liu, et al; Calderwood; and Steinlechner do not overcome the deficiencies of the Munro reference. With respect to the Examiner's comment as to the subject matter of cancelled Claim 5, i.e., that it is inherent that an output signal of a receiver has a frequency equal to the frequency difference between a source frequency and a receiver frequency, Applicant specifically traverses this statement. The output signal of a receiver is dependent upon a great number of factors, and it is clearly not inherent that the output signal of a receiver has a frequency numerically substantially equal to the arithmetic difference between a source frequency and a receiver frequency. The Munro reference as well as the other references of record are at best, silent as to any type of special relationship wherein the output signal of the receiver has a frequency equal to the frequency difference between a source frequency and a receiver frequency. To the extent the Examiner relies upon Judicial Notice for the statement of inherency, Applicant request documentary evidence by the Examiner to support this position of inherency.

Based upon the foregoing, Applicant believes that all pending claims are in condition for allowance and such disposition is respectfully requested. In the event that a telephone

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conversation would further prosecution and/or expedite allowance, the Examiner is invited to contact the undersigned.

Respectfully submitted,

SHERIDAN ROSS P.C.

By: /Brent P. Johnson/

Brent P. Johnson
Registration No. 38,031
1560 Broadway, Suite 1200
Denver, Colorado 80202-5141
(303) 863-9700

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